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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/677,309

10/03/2003

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10/22/2008

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EXAMINER

ARANCIBIA, MAUREEN GRAMAGLIA

ART UNIT

PAPER NUMBER

1792

NOTIFICATION DATE

DELIVERY MODE

10/22/2008

ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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DETAILED ACTION

Claim Objections

1. Claims 8, 9, 11, and 12 are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Specifically, Claims 8, 9, 11, and 12 recite claim limitations now recited in independent Claim 1 as amended.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1, 2, 14-24, and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 3,923,567 to Lawrence in view of U.S. Patent 6,100,167 to Falster et al. and U.S. Patent 5,622,875 to Lawrence (herein referred to as US '875).

In regards to Claim 1, Lawrence teaches a method of reclaiming silicon wafers that includes, in the following order, a film removal process (Column 5, Lines 52-65), a heating/removal process (Column 6, Lines 6-33 and Line 49 - Column 7, Line 31), a polishing process (Column 7, Lines 32-38), and a cleaning process (Column 7, Lines 38-40), wherein the heating / removal process is between the film removal process and

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the polishing process and comprises heating the silicon wafer (Column 6, Lines 6-33) and a chemical process carried out "in air" in that the chemical processing tank would be surrounded by air, that comprises removing a surface part of the silicon wafer by etching the top surface of the silicon wafer (Column 6, Line 49 - Column 7, Line 24).

In regards to Claim 1, Lawrence does not expressly teach that the heating of the silicon wafer is performed at 150-300°C for 20 minutes - 5 hours. In regards to Claim 15, Lawrence does not expressly teach that the heating step of the heating/removal process is carried out in air. In regards to Claim 16, Lawrence does not expressly teach that the maximum temperature is 300°C.

Falster et al. teaches in a method of reclaiming silicon wafers (Column 1, Lines 11-13) a heating / removal process comprising heating the silicon wafer at 100-300°C for a preferred time of several to several tens of minutes up to about 1.5 hours. (Column 3, Line 61 - Column 4, Line 10) These ranges in temperature and time meet the limitations recited in Claim 1. Falster et al. further teaches that heating process can be carried out in air (Column 4, Lines 16-18), and that the maximum temperature can be 300°C (Column 4, Line 3).

(The Examiner also observes that Falster et al. (Column 3, Lines 51-60) further teaches that the time is a result-effective variable that affects the diffusion of copper to the surface of the silicon wafer, and is selected in accordance with the heating temperature.)

It would have been obvious to one of ordinary skill in the art to replace the heating step of the heating / removal process taught by Lawrence with the heating step

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taught by Falster et al. The motivation for making such a modification, as taught by Falster et al. (Column 2, Line 67 - Column 3, Line 50), would have been to diffuse copper to the surface of the silicon wafer without the undesirable copper precipitates that form when the heating is performed at higher temperatures. Moreover, Falster et al. expressly teaches that the heating step taught by Falster et al. is an improvement over prior art gettering methods, since the high diffusivity of copper in silicon makes it possible for copper to escape from the gettering sites and reach the device region of the wafer. (Column 1, Line 64 - Column 2, Line 3)

Further in regards to Claims 1 and 23, the combination of Lawrence and Falster et al. does not expressly teach that the chemical removal step comprises etching the silicon wafer with a solution comprising an alkaline (i.e. basic) hydroxide to a depth of 1 micron.

US '875 teaches, in a method of reclaiming a silicon wafer (Column 4, Lines 31-42), a chemical removal step comprising etching the silicon wafer with a solution comprising KOH to a depth of at least 1 micron. (Column 8, Lines 13-31)

It would have been obvious to one of ordinary skill in the art to further modify the method taught by the combination of Lawrence and Falster et al. to have the chemical removal solution comprise KOH, as an art-recognized suitable etchant as taught by US '875 for that purpose, and to etch the silicon wafer to a depth of at least 1 micron, in order to, as taught by US '875 (Column 8, Lines 13-31), remove impurities from the wafer and to remove an unwanted top surface layer of silicon having considerable crystalline strain.

In regards to Claim 2, Lawrence teaches that the heating / removal process can further include a mechanical removal process (Column 7, Lines 25-31).

In regards to Claims 14, 17, and 18, the heating step of the heating/removal process taught by the combination of Lawrence and Falster et al. is carried out so as to provide a *P-type silicon wafer* having the same specific resistance of a virgin (i.e. unused) P-type silicon wafer, as broadly recited in the claims. (Falster et al., Column 1, Line 11 - Column 2, Line 50; Column 3, Line 12 - Column 4, Line 18; Column 5, Lines 14-29) The heating step of the heating/removal process as taught by the *combination* of Lawrence and Falster et al. would inherently not form any oxygen donors, since the process is performed below 300°C and no dopant is introduced into the wafer. This rejection is based on the fact that the method taught by the *combination* of Lawrence and Falster et al. would inherently result in the reclaimed wafer having the recited properties. When a rejection is based on inherency, a rejection under 35 U.S.C. 102 or U.S.C. 103 is appropriate. (See *In re Fitzgerald* 205 USPQ 594 or MPEP 2112).

In regards to Claims 19, 20, and 22, Lawrence teaches that the method can be carried out to reclaim silicon wafers that were previously used as testing wafers to carry out the monitoring of a semiconductor chip manufacturing process. (*The wafers can be classified as process monitor test wafers...*; Column 1, Lines 30-40; Column 5, Lines 32-35)

In regards to Claim 21, the wafer reclamation method taught by the combination of Lawrence, Falster, and US '875 would inherently produce a silicon wafer without Cu contamination, as broadly recited in the claim (i.e. produce a silicon wafer with a level of

contaminants at or below that of a virgin wafer), since the process taught by the combination of Lawrence and Falster et al. is carried out so as to remove contaminants and provide a *P-type silicon wafer* having the same specific resistance of a virgin (i.e. unused) P-type silicon wafer, as discussed above, and the alkaline chemical etching step taught by the combination of Lawrence, Falster et al., and US '875 etches the wafer to a depth of 1 micron. This rejection is based on the fact that the method taught by the *combination* of Lawrence, Falster et al., and US '875 would inherently result in the reclaimed wafer having the recited properties. When a rejection is based on inherency, a rejection under 35 U.S.C. 102 or U.S.C. 103 is appropriate. (See *In re Fitzgerald* 205 USPQ 594 or MPEP 2112).

4. Claims 5-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lawrence in view of Falster et al. and US '875 as applied to claim 1 above, and further in view of U.S. Patent 5,932,022 to Linn et al.

The teachings of Lawrence, Falster et al., and US '875 were discussed above.

In regards to Claims 5 and 6, the combination of Lawrence, Falster et al., and US '875 does not expressly teach that an immersion process for chemically processing the silicon wafer should be performed in addition to the heating / removal process between the film removal process and the polishing process, or that the processing liquid can be any of the liquids recited in Claim 6.

Linn et al. teaches an immersion process for chemically processing a bare silicon wafer should be performed prior to a heating step 115 (Figure 1), wherein the processing liquid can be a mixed solution of hydrogen peroxide, ammonia, and water

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(SC-1 cleaning solution; Step 101; Column 3, Lines 13-20), or a mixed solution of hydrogen peroxide, hydrochloric acid, and water (SC-2 cleaning solution; Step 109; Column 3, Lines 55-65).

It would have been obvious to one of ordinary skill in the art to modify the combination of Lawrence, Falster et al., and US '875 to include an immersion process for chemically processing the wafer just before the heating / removal step, with processing liquids taught by Linn et al. The motivation for making such a modification, as taught by Linn et al. (Column 4, Lines 43-49), would have been to perform the heating step on a wafer with a relatively metal-free, hydrophilic surface, such that the finally processed wafer has an increased minority carrier diffusion length.

In regards to Claims 7, 8, 10, and 11, Lawrence teaches that the heating / removal process can include a mechanical removal process (Column 7, Lines 25-31) and a chemical removal process (Column 6, Line 49 - Column 7, Line 21).

In regards to Claims 9, 12, and 13, the combination of Lawrence, Falster et al., and US '875 as applied to Claim 1 above teaches that the chemical removal step can be performed using alkaline hydroxides, specifically potassium hydroxide.

5. Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lawrence in view of Falster et al. and US '875 as applied to claim 1 above, and further in view of U.S. Patent Application Publication 2004/0108297 to Erk et al.

The teachings of Lawrence, Falster et al., and US '875 were discussed above.

In regards to Claim 24, the combination of Lawrence, Falster et al., and US '875 does not expressly teach that the wafer is etched in the chemical removal step with a solution comprising an alkaline carbonate.

Erk et al. teaches that an etching solution for silicon wafers can comprise an alkaline hydroxide, and additionally an alkaline carbonate, such as potassium carbonate. (Paragraphs 43, 48, and 54-63)

It would have been obvious to one of ordinary skill in the art to modify the etching solution for the chemical removal step taught by the combination of Lawrence, Falster et al., and US '875 to further comprise an alkaline carbonate, such as potassium carbonate, as taught by Erk et al. The motivation for making such a modification, as taught by Erk et al. (see at least Paragraphs 61-63), would have been that the addition of a salt additive such as potassium carbonate contributes to improved surface characteristics of the etched wafer.

6. Claims 26 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lawrence in view of Falster et al. and US '875 as applied to claim 1 above, and further in view of Erk et al. and U.S. Patent 5,810,940 to Fukazawa et al.

The teachings of Lawrence, Falster et al., and US '875 were discussed above.

In regards to Claim 26, the combination of Lawrence, Falster et al., and US '875 does not expressly teach that the chemical process of the heating/removal process further comprises top surface cleaning the silicon wafer with an aqueous solution comprising hydrofluoric acid and hydrogen peroxide after etching.

Erk et al. teaches that a wafer should be cleaned after etching. (Paragraph 80)

It would have been *prima facie* obvious to one of ordinary skill in the art to include a cleaning step after etching the silicon wafer in the chemical removal process of Lawrence, Falster et al., and US '875, for the predictable result of washing off the spent etchant and other impurities from the surface of the silicon wafer.

Fukazawa et al. teaches that an aqueous solution comprising hydrofluoric acid and hydrogen peroxide is a suitable cleaning solution for a silicon wafer, especially for removing copper impurities from the surface of the wafer. (see at least Column 5, Lines 11-15 and Column 6, Lines 16-20)

It would have been *prima facie* obvious to one of ordinary skill in the art to use an aqueous solution comprising hydrofluoric acid and hydrogen peroxide to clean the silicon wafer after etching in the method taught by the combination of Lawrence, Falster et al., US '875, and Erk et al., as an art-recognized suitable cleaning solution, as taught by Fukazawa et al., for the intended purpose of cleaning and removing copper impurities from the surface of the silicon wafer.

In regards to Claim 27, the Cu concentration of the silicon wafer after said top cleaning step in the combination of Lawrence, Falster et al., US '875, Erk et al., and Fukazawa et al. would inherently be no more than 2×10^{12} atom/cm³, since the combination of Lawrence, Falster et al., US '875, Erk et al., and Fukazawa et al. teaches an identical chemical processing method to that claimed by Applicant, and the action of the same chemical processing steps to a contaminated silicon wafer would be expected to have the same results as those disclosed by Applicant. When a rejection is

based on inherency, a rejection under 35 U.S.C. 102 or U.S.C. 103 is appropriate. (See *In re Fitzgerald* 205 USPQ 594 or MPEP 2112).

Response to Arguments

7. Applicant's arguments, see Pages 9-10, filed 2 July 2008, with respect to the rejection(s) of claim(s) 1 under 35 U.S.C. 103(a) as obvious in view of the combination of Lawrence, Falster, and Chai, specifically that the teachings of Chai do not fairly suggest using a solution comprising an alkaline hydroxide to etch the silicon wafer to a depth of 1 micron, have been fully considered and, *in view of the amendment to Claim 1 to require that the silicon wafer is etched using the solution comprising one or more of an alkaline hydroxide and an alkaline carbonate to a depth of about 1 micron*, are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Lawrence, Falster, and US '875. Specifically, the teachings of Lawrence and Falster are still applied to features of Claim 1 not argued by Applicant in the Remarks filed 2 July 2008, and the teachings of US '875 remedy anything lacking in Lawrence and Falster as applied to Claim 1.

8. Applicant's remaining arguments filed 2 July 2008 have been fully considered. Examiner notes Applicant's arguments that etching with an alkaline solution provides a means of reducing the Cu concentration in silicon wafers by an amount that is substantially greater than the amount of Cu reduction that is achieved with other types of etching. However, Examiner notes that the combination of Lawrence, Falster, and US '875 now applied to Claim 1 teaches etching the silicon wafer using an alkaline solution to a depth of 1 micron, and therefore, by applying the same chemical

processing steps as Applicant, would be expected to produce the same result of reduced Cu contamination.

Conclusion

9. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAUREEN G. ARANCIBIA whose telephone number is (571)272-1219. The examiner can normally be reached on core hours of 10-5, Monday-Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Parviz Hassanzadeh can be reached on (571) 272-1435. The fax phone

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number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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Examiner, Art Unit 1792

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